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ABSTRACT

In an effort to improve students' transition from the classroom to the workplace, four instructors from the New Hampshire Community Technical College System integrated the National Skill Standards (NSS) into the curriculum of their programs. This report illustrates how these instructors transformed their teaching, student assessment, and instructional methods and provides recommendations for the use of the NSS as the foundation for curricula. Following an introduction to the "Virtual Workplace," or the envisioned classroom of the future where students master and perform workplace skills, the first section of the report describes the process of integrating the NSS into curricula, including the search for an appropriate set of standards, the role of the instructor in preparing curricula, student-employee assessments, advantages of teaching and learning in the Virtual Workplace, and problems arising in the process. The second section discusses the current status and successes of the four programs; lists the roles and responsibilities of the faculty, students, and business and industry; and details key considerations for undertaking student assessment. Finally, the third section presents commendations, recommendations, and questions related to the integration of the NSS into curricula. Contains 12 references. Appendixes include the Virtual Workplace work plan, a questionnaire for participants, faculty responses to the questionnaire, and a model skills point system for student assessment. (TGI)

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A Pedagogy Blueprint For The 21st Century:

Pedagogy and Assessment Implications of "Using Voluntary National Skill Standards in Performance Based Curriculum Design"

by PEDAGOGY COMMITTEE

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New Hampshire Community Technical College System

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Table of Contents

A Pedagogy Blueprint For The 21st Century 1

Appendices

Appendix A: The Virtual Workplace Assessment Work Plan 20
Appendix B: The Virtual Workplace Questionnaire 22
Appendix C: Faculty Responses to the Questionnaire 24
George Dysktra 24
Jackie Griswold 27
Dave Miller 29
Sonia Wallman 32
Appendix D: Student Assessment:
Skills Point System Example 35

A Pedagogy Blueprint For The 21st Century

Once each student crosses the threshold into The Virtual Workplace they are immediately transformed into an employee of a virtual business. The first day on the job, skill standards and general expectations are clearly articulated by the instructor-employer. The student-employee quickly learns this unique educational environment is a "hands-on" learning experience where information is not obtained from a lecturing instructor nor from cookbook lab experiments. Instead, students, organized into teams, are working with team members collecting, interpreting, analyzing and evaluating data for the purpose of problem solving. Individual student-employees are held accountable for performing each task competently and for eventual mastery of skill standards. Meanwhile the instructor oversees the operation of The Virtual Workplace through the preparation of lessons and lab assignments, using the skill standards for their occupational area as the focal point.

From this vantage place one can see the 21st century classroom. Yet, one can also see back to the future. For all its outward sophisticated employment of high tech equipment, The Virtual Workplace is a throwback to the Middle Ages' world of apprenticeships. The major difference between these two worlds is the specifically prescribed written performance skill standards from which the program, the course content, methodology, and student assessment flow.

Like the apprentice in the Middle Ages, students learning in The Virtual Workplace experience an on-the-job training program that fully prepares them to easily move into a job in the real workplace. Upon entering The Virtual Workplace the student becomes a professional who works and behaves as a professional. Each student-employee is evaluated using the same skill standards as industry. The student-employee must demonstrate a required level of competency and mastery of each skill. Documentation is on a sliding scale; 1 = aware, 2 = competent, 3 = master, and 4 = expert. To evaluate the student-employee's performance, the instructor-employer utilizes observations, student-self assessments and observations, written evaluations, memos, and reports. In addition, student-employees are given a series of pencil and paper evaluations - quizzes, tests, research projects, final exams. Through this multi-plex assessment structure the instructor-employer has quality information to objectively assess the student-employee's degree of mastery of the skill standards. Yet, the moment of truth comes for both the student and instructor when the student-employee goes into the world of the industry partners. To date the students from The Virtual Workplace have received enthusiastic assessments from their industry employers. This is high praise and a high endorsement for the way The Virtual Workplace prepares students for the real workplace.

Oh sure, there are a few student-employees who have difficulty adapting to this new "hands-on" learning style; nevertheless, during the first semester many of those same students eventually adapt and thus survive and flourish in The Virtual Workplace. According to the instructors, attrition in their programs is low compared to other programs.

With this concise overview of The Virtual Workplace as a foundation, it is appropriate to discuss in greater detail the primary components of The Virtual Workplace.

LOOKING BACKWARD

Integrating the National Skill Standards (NSS) into curriculum development dramatically changes the learning and teaching landscape. Teaching methods, student assessment and time based instruction are all radically transformed. Therefore, any contemplation of change should be thoughtfully and carefully considered. It would be helpful to understand how the four instructors went about the process of changing their respective programs - Automotive, BioTechnology, Electronics Engineering Technology, and Human Services--using the National Skill Standards as the foundation for their curriculum.

The Genesis Of Change

In the beginning the instructors search for the appropriate set of National Skill Standards written by business, industry, and educational leaders for 22 specific professions. Perusing the National Skill Standards one sees these are divided into cognitive - skills, knowledge, application, analysis, synthesis and affective - values, ethics, interpersonal skills. These skill standards are written in performance based terms precisely defining the specific job performance task expected of the learner.

Since the National Skill Standards offer an extensive listing of performance tasks, the instructors must carefully select the skill standards to include in their programs. Once this difficult selection process is completed the instructors are ready to begin the program's construction phase with the courses. Since course content is identified by those National Skill Standards the instructors selected, course development should be the easiest phase of this major overhaul. One of the most challenging aspects to this unique approach is the impact on methodology. At this moment questions are probably racing wildly through a prospective instructor's mind with one question looming above the others: can I use my present methods to implement the National Skill Standards? However begrudgingly, one must concede that drastic changes demand drastic measures. Continuing to use traditional methods will not as effectively nor as efficiently fulfill the performance requirements listed in the National Skill Standards as will a non-traditional methodology.

Dave Miller, Electronics Engineering Technology, Concord, speaking for the other project instructors concurs: "The traditional modes of instruction were unable to address the essential needs identified by the skills standards." With a current of the Manufacturing Process running through the National Skill Standards, why not transform the classroom into a virtual workplace that replicates the world of work? In The Virtual Workplace the students are employees who perform the daily job routines and expectations by fulfilling the job's expectations as defined by the National Skill Standards. The classroom or laboratories are divided into work-stations where the student-employees work on specifically designed jobs or projects. It is a simulated world of work where the student-employees work in teams cooperatively collecting and analyzing data.

The Instructor's Role In Creating The Virtual Workplace

Meanwhile, the instructor's role in The Virtual Workplace is to prepare the various assignments and lessons for the respective job experiences. To help the student-employee understand the performance

criteria the instructor builds a check list using the National Skill Standards for each job within the lesson. In addition to prepping and organizing courses, lessons and assignments predicated on the National Skill Standards, the instructor's role is also dramatically transformed. No longer is the instructor the central focus; in The Virtual Workplace the learner is the focus. There is a shift from the teaching paradigm to the learning paradigm. Multiple methods emphasizing the learner centeredness are constantly at the ready position waiting for the instructor to pick and choose the appropriate method at the most propitious moment to enhance the student's learning. Lecture, the traditional teaching staple, is available to acquaint and to introduce the student-employees to new lessons, materials, and lab experiences. Since the responsibility for learning is given to the student-employee, the instructor implements other methods such as: cooperative/collaborative learning, multi-media presentations, computerized instruction, individualized-self-paced instruction, role play, and simulations that actively engage students with learning. Consequently, in this learning center the instructor has multiple roles to complement the multiple methods: boss/employer, lecturer, facilitator, guide, counselor, and organizer. With the flair of the rapper's poetic phrases Dave Miller aptly describes the instructor and student's roles as synchronous: "For the teacher, the roles of sage on the stage, 'guide on the side,' and mentor in the center are augmented by the learner on the burner. For the students, the learner on the burner role is augmented by the sage on the stage, 'guide on the side', and mentor in the center." Teacher and student roles are fluid, constantly changing. It is Paulo Freire's, ("Pedagogy of The Oppressed"), learning world of students as teacher and teacher as student.

Assessing Student-Employee In The Virtual Workplace

Designed from the National Skill Standards, the performance charts developed for each lesson provide a checklist to chart, monitor, and track a student-employee's progress in mastering the performance skills. To determine student mastery in the learning centered experience, the instructor melds the traditional assessment tools with a series of non-traditional assessment tools. Yes, pencil and paper assessments are visible in The Virtual Workplace. Student-employees are quizzed and tested to assess knowledge. To further assess the student-employee's job performance, non-traditional assessment tools such as job reports, project designs, job reviews, memos, anecdotal records, and documentation of work performed are also used. Combining both the traditional and the non-traditional assessment instruments, a more accurate and comprehensive assessment of the student-employees' performance is secured.

Advantages To Teaching and Learning In The Virtual Workplace

In The Virtual Workplace where the learning paradigm, has supplanted the teaching paradigm, the student-employees from day one are immersed in the world of work cooperatively performing jobs where they will learn the essential skills of their chosen field. Upon graduating, the learner will advance from The Virtual Workplace to the real workplace with ease. Since the graduate has a work experience education where they mastered the skills outlined by the business/education community, this graduate is attractive to business as an employee. As a result, there are no surprises for either the newly hired employee or the employer. Both The Virtual Workplace and the real workplace share a common bond of job performance standards. Finally, what brings all this together and makes it a successful learning experience is The Virtual Workplace requires students to assume responsibility for their learning. As Jackie Griswold, Director Health and Human Services Program at Berlin, observes: "They know what they need to learn very specifically and are able to figure out what to do to learn the skills."

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Surprises Abound For The Instructors

The four program instructors were surprised with the students' acceptance and adaptation to The Virtual Workplace. According to the instructors, most student-employees from the get-go performed their jobs as professionals.

During the curriculum development phase the faculty saw clearer than previously the interconnectedness of the courses in their respective programs. Consequently they came to appreciate the Gestalt.

Finally, the four faculty members were pleasantly surprised with the visible similarity of the education process method used by each of the four instructors to prepare students for the world of work; this is when they decided to name their learning world A Virtual Workplace. Their biggest surprise occurred when they noticed how similarly the four of them included the affective domain in their curriculum.

Oh, Come On; This Is Too Good To Be True!

Well, yes it is. The Virtual Workplace is not without blemishes. It is not the perfect learning world. Annoying problems constantly grate the instructors' nerve endings. The four instructors candidly admit to a variety of problems they confront daily.

- More time is required to work on this project
- More understanding by the colleges of what it means to change from a time based to a performance based learning is necessary
- Implications this change has on grading policies are unclear
- Skepticism and negativity from both administration and faculty toward change are unsettling
- Student skepticism and insecurity at first makes them uncomfortable with this new learning world.

Even with these problems, the four instructors defiantly stare directly into the tiger's eye, discovering ways to work around and over these obstacles. Their unbridled excitement and enthusiasm act as a protective shield deflecting the slings and arrows thrown at them. Their commitment to The Virtual Workplace is unwavering. They are true believers who patiently and at times impatiently await the time when administration and other faculty learn more about this brave new learning world.

Worthwhile change does not occur without pain, and at times the pain can be excruciating. The question then is: are you willing to suffer through the agony to eventually enjoy the ecstasy? If the answer is yes, then be aware that change operates on a five year plan. It takes approximately five years to debug, to revise, to edit the inherent glitches and flaws in any program change. Presently, these four instructors are in the third year of the five year plan. Through hard work these four instructors are speedily heading toward their original vision of The Virtual Workplace.

LOOKING AT THE PRESENT

"This is my proudest thing --lately!" enthused Biotechnology Professor Sonia Wallman. That quote reveals two essential outcomes of successful implementation of voluntary National Skill Standards in performance based curricula. First and foremost the professor is proud of her work; secondly, the word "lately" emphasizes how her pride obviously includes change as her work evolves.

Successful pedagogy depends on those two awareness as: pride in what has been achieved but expectation of new achievements. Successful assessment builds from connections of those awareness to student, faculty, and program outcomes.

The range of successes in the four very different programs -- Advanced Automotive Technology, Biotechnology, Electronic-Systems Technology, and Human Services -- and from their four lead faculty -- George Dykstra, Sonia Wallman, David Miller, and Jackie Griswold who differ significantly in backgrounds and approaches -- urge faculty in all disciplines to choose their road less taken that makes such a difference.

And what makes this difference? These four faculty have become so immersed in the totality of their work that evidence specifically about teaching and assessment can be gleaned only fragmentarily at this juncture of their work.

In Advanced Automotive Technology George Dykstra moved from "how we were going to have my students actually demonstrate their ability to do the work" (assessment) to beginning "to build the program and the curriculum around them" (pedagogy). Since it is the STUDENTS who "learn to develop those skills that are necessary to meet the skill standards," George sees the "moving towards a more student-centered, competency-based model" as the overall strength of the project. Pride in that achievement is mediated by needs to reshape the "neither large nor complex" curriculum around the student, taking "much more time than would normally transpire in a lecture/lab situation," going "outside, way outside, the normal classroom hours in order for students to complete their task." Separate lecture and lab hours "have merged together where students will spend the time necessary for the development of their skills in the area and in the ways that will serve them best."

Time is the problem for instructors as well. George is 75% complete in integrating this model into all the program courses. He hopes to extend the approach to other postsecondary and secondary programs. For both expansions he needs time. In addition development of materials, including multimedia, and development of enduring individual interactive relationships supporting the learning of each student require time. How to achieve all this is an ongoing problem, but the response of employers who "are much happier with the quality of student that we are turning out to them" makes the problem one that George's whole college must own. Industry, which donates equipment, vehicles, and zone people to visit classes in operation -- models fullness of commitment that is essential for even more success. An additional challenge is that subject matter, as the automobiles do, changes each year, becoming "a moving target" for the instructor who must review and change as needs change. In fact General Motors itself is shifting over to hands on, competency based work, so education is influencing the industry as much as industry influences education.

In Biotechnology Sonia Wallman "created" both "a real biotechnology work place centering real world biotechnology tools (A Virtual Workplace) "and" a logical series of biotechnology research protocols and manufacturing standard operating procedures that use these tools and serve to unveil the entire biotechnology content area to the student." The pedagogy is the creation.

One of the assessment standards for Biotechnology is that the student see "the relevance of their education and training to the workplace." The protocols include documentation of performance of skills acquired; a final exam assesses knowledge; memos from fellow students as well as observation and documentation by instructor assess attributes. New protocols have been and need to be added (the time and support factors again limit.) The Sloan Foundation supports this effort by funding conversion into a format that can be delivered over the Internet to learners in the workplace. The changing course and assessments reflect "a work in progress."

In Electronic Systems Engineering Technology David Miller not only divided skill standards into the 3 dominant groupings of skills, knowledge, and attributes but also identified the overlay between skill standards as strongest in the area of attributes, "an observation that is recognized as a keystone" of his project effort. He encouraged industry methods and assessment techniques such as "team and collaborative work, progress reports, proposals, memo, design reviews, and assessment by peers, self, and management against the industry performance based standards."

In Human Services Jackie Griswold entered the project "to validate my curriculum" "to know where changes might need to be made, and to develop a means of measuring student mastery of curriculum by using methods to measure student performance of skills." Her task "was one of integrating the skill standards into the curriculum...more unwieldy and difficult than starting with the standards and developing a curriculum on their basis." In Human Services assessment uses "a combination of instructor observation of student performance and student self observation and self reporting". Job descriptions and performance areas in the human services agencies are also being developed with skill standards, so the education again is influencing the industry. As a curriculum, Human Services have "more interconnectedness between courses and require more personal growth...there is a lot of assessment of character." In Human Services "all the skills were present in the existing curriculum, but there needed to be a more balanced distribution over the courses." Practicum courses moved to a new role as capstone courses, "opportunities for students to exhibit mastery of most, if not all, skills taught in the program." In the future skills standards will become "the basis for student evaluation and course grades." Such assessment will require increased use of out-of-class time.

In each of these very different programs students are moving from a course by course kind of learning to an integrated whole set of skill standards where the pattern of expected development is clearly stated. Students are actively looking at what they know, how they learn, and how they demonstrate mastery; learning for them becomes steps of the continuum that previously they became aware of only by looking backward. Not only faculty but also students are recognizing the different pathways to master, respecting the different choices, whatever road each travels.

More specifically though, in this "age of the standard," what are specific implications for pedagogy and assessment?

PEDAGOGY

Faculty does:

- behave enthusiastically and with commitment
- develop virtual workplace curriculum
- align standards with currently existing courses
- define logical sequence of skill development
- infuse skills into curriculum
- level skills
- correlate lab and lecture assignments
- develop activities
- search out appropriate materials for students for use in learning process
- write own training manual
- revise and review curricular material
- provide students with needed additional information including books, journals, vendor catalogs, videotapes, audio tapes, and the Internet as sources
- open labs to allow students greater access to instructor, tools, and equipment
- teach synchronously including texts, videos, Internet, video conferences, on site presentations, site visits, and tutorials
- link technical and academic courses
- design instructional activities on real life basis
- enable students to articulate skills of chosen profession
- enhance understanding and appreciation of profession
- help students to present skills to employers
- utilize state-of-the-art equipment found on the job
- expose students to the whole range of the work in experiential learning

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- help students relate their work to the skills the work builds
- collaborate with industry on projects
- provide equipment, supplies, and industry-recognized protocols
- let students, working as individuals in teams, take over to organize and carry out the work
- level from 1) Awareness to 2) Competency then 3) Mastery and 4) Expertise, allowing flow back and forth as new elements are added
- revolve instructional methods around the best way to demonstrate skills and the best ways for students to demonstrate to the instructor skills learned
- enlist the help of students and rely on them to help devise instructional methods
- consult with students as to goals, reality of goals, and how to achieve them
- promote student-driven learning
- customize instruction for needs and characteristics of students
- respect and give credit for unique learning pathways of individual students
- develop more interactive, more student centered models for teaching
- coach
- group instruction with problem-solving activities
- use lecture for introductions (spend less time lecturing)
- engage in applied academics (case vignettes, role play, multi-media and computer simulations, scenarios, internships, site visits)
- act as facilitator/consultant to individuals/groups
- develop portfolios where students present skills developed

Students do:

- know what they need to learn and actively figure out what to do to learn skills
- get to work the minute they come in
- learn at own pace
- research what exists; try; apply

- learn all the jobs in the work
- interact with all aspects of a field

Business and industry does:

- give lectures and share their training background
- consult
- assess and give feedback
- provide access to equipment
- keep faculty current with industry methods
- introduce students to people in industry settings

ASSESSMENT

Assessment attempts to:

* be ongoing and constant
* be collaborative with roles for both students and faculty
* include student responses
* encourage students to ask questions freely
* provide more consistent, objective, and standardized means of granting credit for prior learning
* connect program skills to General Education
* incorporate industry practices as benchmarks in curriculum design
* require performance of tasks that require mastery of skills
* recycle student who is not having success back to learning activities (not to an F)
* experiment with barcoding all skill standards and students so, as what is seen is entered, matches occur
* use Internet as an electronic trail of leaning styles to teach which work best for each skill
* find ways to more concretely assess attainment of skills, knowledge, and attributes
* use, require, and document attributes in class
* communicate to students required strengths such as leadership, independent work, ability to learn on own, seeking out information, and progressing to succeed
* focus on what behaviors document skills, value, or attitudes
* require samples of work as proof of skill attainment
* include not only objective work but also "Select favorite piece of data" in lab notebooks
* use portfolios
* record what was done to successfully carry out each student activity
* generate a review form grouping functionally related sets of standards, augmented by correspondence, anecdotal notations, and documentation of work performed in order to have a comprehensive performance record of each student
* consult constantly about goals and how to achieve them
* help students express their changing goals
* assess how to assess
* seek feedback on courses
* replace grade with pride in performing work and internal reward

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LOOKING FORWARD

As works in progress these four innovative programs are constantly scrutinized and evaluated by the four instructors. Courses and units are fine tuned, integration of skill standards with student assessment are studied and formulated, variations in the ways students acquire skills and improvement of documentation of student achievement are pursued. Dave Miller with an eye on the future summarizes, "The challenges ahead are primarily in creating changes in the management and the traditional expectations of the education industry to incorporate performance based learning informed by (the) National Skill Standards."

The integration of the National Skill Standards into these four programs - Human Services, Electronic System Engineering Technology, Advanced Automotive Technology and BioTechnology - has a profound educational fall- out for the instructors, their students, their colleges, and the community technical college system. The changes they implemented are groundbreaking. These are exemplary programs.

As Jackie Griswold enthusiastically testifies, "Using skills standards resulted in less lecturing, less conventional testing, more instructor time spent 'coaching'. There is an increased use of portfolios. Prep work for classes has increased as emphasis on ways of assessing and documenting acquisition of skills has increased. More responsibility has been given the students for devising ways of practicing and assessing skills."

George Dykstra, Laconia, elaborates, "...teaching methodologies are going to revolve around the necessity for students to become more involved in their education process."

Sonia Wallman, Stratham, adds "I do all the planning for the course, provide all the tools (equipment, supplies, wet ware) and industry recognized protocols and SOPs (Standard Operating Procedures). Then I let the students take over. They work as individuals in teams. They organize and carry out the work of the day. I take a back seat..."

Lastly, Dave Miller concludes, "Teaching under A Virtual Workplace /PBLs/NSS system involves significantly more learning and substantially less preaching than traditional methods. Since the problems are real they do not have (a) singular right answer. ...conceiving, evaluating, developing, assessing solutions to problems creates continuing changing activities and sets of knowledge and skills for success."

These four apostles of change, using the National Skill Standards as the foundation for their respective programs shed many of their traditional notions of teaching and learning and willingly dove into the chilly, uncharted waters of educational change. Furthermore, as the positive results from these changes multiplied, they unabashedly trumpeted the virtues of shifting from the teaching paradigm to the learning paradigm with the aim of converting other instructors to A Virtual Workplace method.

Having seen both sides of the teaching and learning paradigms, they are convinced beyond a reasonable doubt of the efficacy of the learning paradigm because of its effectiveness in teaching students to learn. When students are engaged in the learning paradigm, they become involved with the learning process which prepares them to master job-related skills, expand their global awareness and perceive relevancy of learnings acquired in one course to those in other courses. Meanwhile, the instructors with their flexible pedagogical approach customize instruction to match student needs and characteristics. In A Virtual Workplace both students and instructors are empowered.

Implications For Faculty

Frequently when standards come from on high, the educational world suffers. Such a top down approach reinforces business as usual. Apparently the National Skill Standards defies this outlook and challenges the educational community to change. At least the four instructors in this study construed the skill standards this way and created the unique and useful Virtual Workplace where the instructor and students teach and learn through a manufacturing process. In this replicated world of work, students learn the ins and outs of their chosen careers with an on-the-job learning experience. The Virtual Workplace's multiple methodologies are employed to elevate student learning accompanied by multiple assessment tools --traditional and nontraditional -- to assess students' learning progress. Not only do students learn skills, knowledge, analyses etc. but they also learn how to work together, how to get along with each other to achieve their expected goals, and what values and ethics are appropriate for both the world of work and beyond. These exemplary programs are models for change. There is much we can learn from the four instructors' adventures into the educational world of innovation predicated on the National Skill Standards.

Commendations And Recommendations

At this time it is appropriate to offer commendations and recommendations that arise from the study of the four New Hampshire Community Technical College System innovative programs based on the National Skill Standards.

Commendations

* The shift from a teaching paradigm to a learning paradigm requires more student responsibility for their learning
* Utilization of multiple primary methods helps students learn
* Transformation of the classroom/lab into a virtual workplace offers on the job learning experience
* Programs are focused on meeting student needs
* The project implements performance-based learning in diverse program areas
* College standards are defined on an industry baseline
* Interacting among peers from different programs is ongoing
* Peers adapt to unforeseen and foreseen glitches and recognize the need to fix these glitches
* Collaboration across disciplines is being modeled
* Similarities across programs, not just differences, are identified
* Publication in Tech Newz, presentation to secondary, postsecondary and to Pedagogy Symposium faculty promote wider involvement from other technical and academic areas
* Communication across system within Human Services faculty has pulled in other campuses where faculty are willing to try this approach
* Project responds to need to identify and integrate prior work and life experience
* Project responds to perception that so-called soft outcomes aren't measurable, eg attitudes and values, and integrates these with more traditionally measurable outcomes
* Virtual Workplace transforms classroom from merely a location into a learning tool itself
* Advanced Automotive Technology uses national skill standards as a tool of communication with General Education faculty, high school faculty, and employers
* Electronic Systems Engineering Technology begins student experience as workplace by not enrolling in a course but applying for a position

- Human Services calls national skills into play through role playing, and in mini dramas that illustrate work activities and scenarios
- Pedagogy becomes performance based when skill standards are written for performance
- Individualization is enhanced through skill standards
- Faculty who developed skill standards have better ability to implement them, will be more committed to sharing them
- Employers are excited about shared benchmarks and might more willingly participate in designing how those benchmarks could best be achieved; the partnership would deepen
- Assessing students properly requires more than traditional methods; therefore the documentation of assessment itself is labor intensive
- Learning sites in both classroom and workplace can be integrated
- Courses integrate skills into a hierarchy recognizable and accessible to learners
- Faculty are enthusiastic and committed
- Students, who some worried would only learn well in the traditional lab/lecture situation, began to work well with this system of learning
- Students are able to PERFORM the work
- Both traditional and non-traditional assessment tools are utilized
- Communication between college and the industry is ongoing
- Use of skill standards gives educators a more concrete understanding of the needs of industry
- Independent learners are being created
- Creating lifelong learners is a goal being worked toward
- Biotech published in-house lab material (with former students)
- Programs are sought statewide by both educators and employers
- Students know what is expected
- Students with limited backgrounds are able to learn difficult subject matter
- Faculty has become more involved with industries that utilize faculty's discipline
- Students have a clearer idea of what they should know and what they do know
- Graduates of program can be marketed to the industry better, and students can market themselves better

- Students assume more responsibility for their learning
- Students see more wholes organically
- Students recognize universality of skill standards
- Sonia Wallman has the ONLY biotech site on the glob -- http://biotech.tec.nh.us
- Commissioner Rafn has always evidenced strong support as have Keith Bird and Ann Weddleton
- Project has expanded and accelerated in two years far beyond what was expected for completion results three years
- Innovation is systematic
- Transition for students from A Virtual Workplace into the business and industry workplace is smoother

Recommendations

- Provide data showing more learning occurs in the learning paradigm model versus the teaching paradigm model
- Implications that only faculty could recognize as they work through their teaching must not get lost (ie not reported) because faculty are doing tasks which could be done by support staff
- Face time concerns, from how long students take to master learning to change from standard semester and weekly contact hours; revolve time around what learning requires
- If performance based learning is a System priority, the System must more visibly support lead faculty practitioners, ie. dollars for equipment, local technical assistance, secretaries, work study, assistants, assessments, and tutors.
- Document aspects of implementation more completely
- Document student assessment/evaluation of the methodology
- Increase level of commitment of Presidents and Vice Presidents of Academic Affairs in direct support of faculty; insure that presidential support is clearly visible to rest of campus and to workers of business and industry
- Address ongoing need for continuing education to keep faculty current in their fields
- Appropriately fund maintenance of well-equipped labs and facilities
- Fund appropriate staff development
- Send lead faculty out to give workshops to other System faculty; time must be appropriated for such work (not be another add-on)
- Facilitate articulation with high schools and four year college
- Integrate core competencies; that core might lead to clearer seeing of commonalities
- Establish a "Partnership" with General Education
- Integrate program skill standards with General Education
- Track through pre and post testing of some kind
- Increase the variety of ways students can master skills, and document the mastery
- Implement Alumni assessment of virtual workplace pedagogy
- Implement employer assessment of NHCTC virtual workplace graduates versus students who graduated from a traditional lecture/lab

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Questions That Remain

- Since skill standards are silent on HOW standards should be learned, what are the parameters for successful learning?
- How do instructors keep pace with changing standards? How do they learn what to teach?
- What in this 'project' most helped to improve student learning?
- What most consistently crosses all four programs?
- What kinds of connections are students making? How are faculty aware of student assessments of connections?
- What benchmarks are the same or similar?
- How do General Education skills implied in the work of a skilled technician gain focus?
- How should high schools best prepare the way to Virtual Workplace programs?
- If labor intensive documenting and assessing student progress slows spread of reforms, how can this slowing become a benefit?
- What should be replicated? Why?
- How will unique skills performed or unique work achieved be recognized (ie. outside the skills "box")?
- What are the most appropriate spinoffs to other areas?
- How will the core competencies be integrated?
- Are attributes that crossover in the four programs a new element of a core?
- How do student views of learning impact change?
- What is the source of money for updating equipment and sustaining expensive technology?
- How can faculty be supported in balancing technology, contact with industry, preparation, pedagogy, funding, teaching, assessing, etc.?
- What will be the role of traditional grading systems?
- How will individuals hold up under the "work harder" ethic?
- How will program and academic skill standards be integrated and/or related?
- How can recognition of likenesses in processes of instruction and assessment as well as of attributes be built into other learning areas?
- How will college policies change to support competency based assessment?

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Appendices

Appendix A

The Virtual Workplace Work Plan

1. History of Project
2. Context of the Project (National Movement, Pedagogy, System initiatives)
3. Definition of the Project Process
   - Who was involved?
   - What they did
   - Methodology: Instruction and Assessment
   - Integration of skill standards with prior methods and materials
   - Challenges the skill standards presents
5. The Results of the Project
   - Students' responses
   - Instructors' responses
6. Interpretation/Analysis
7. Implications for other faculty/System
   - How to
   - Cautions

- collect data .. compile information
- the history
- findings in terms of PBLOs, teaching and assessment
- analysis of findings: National Skill Standards on teaching and assessment (audience/faculty)
- student assessment of the projects
- Monograph Report compilation: interviews; curricula materials; assessment models
- Article "Pedagogy Journal"
  Impact on Teaching and Assessment

Deliverables

1. Work Plan
2. Final Report

Timeline

June 14 = Work Plan

June 14 = Copies of faculty materials assembled and sent to Denise St. Cyr/Manchester; Bill Wheeler/Laconia; Paul/Nancy Marashio/Claremont

June 30 = Questionnaire/Interviews completed materials with commentary return to Paul/Nancy/Claremont

July 20 = Rough Draft

August 19 = Final Draft

Bill/Denise = George Dykstra/Jackie Griswold
Paul/Nancy = David Miller/Sonia Wallman

Reminder. Keep tabs on your time.

Thank you.

Respectfully submitted,

Paul

Appendix B

The Virtual Workplace Questionnaire

1. How did you get involved in this project?

2. How did you apply the National Skill Standards to your instruction?

3. How did you apply the National Skill Standards for your assessment?

4. What strengths do you see coming from this project?

5. What surprised you?

6. What problems did you encounter?

7. How did you cope with the problems?

8. What changes have you made?

9. What changes are you planning to make?

10. What benefits would faculty in other academic and technical disciplines discover if they use National Skill Standards for their own fields?

11. What differences did it make in your teaching?

12. Is this methodology the most effective vehicle to deliver information to your students? Why or why not?

13. List the documentation you possess that supports your responses.

14. Additional comments:

* If you are willing to participate in a face-to-face interview please contact:

George and Jackie = Bill Wheeler/Denise St. Cyr/Laconia/Manchester
Dave and Sonia = Paul Marashio/Nancy Marashio/Claremont

Thank you.

Appendix C

The Virtual Workplace Questionnaire

George Dykstra

1. How did you get involved in this project?
I became involved in this project after talking with Dave Ronco, one of the original writers of the grant. I have an interest in the development of quality education for our postsecondary system. I thought this was an opportunity to further these goals.

2. How did you apply the National Skill Standards to your instruction?
When we got involved with this project, we sat down and took a look at how we were going to have our students actually demonstrate their ability to do the work. Listed below is an example of tasks which students must accomplish in order for them to develop a thorough understanding of the electrical concepts and components used in current production automobiles.

You can expect your student to have knowledge and be able to do the following task as noted in the GM Automotive Electricity Program.

TASK	NO SUPERVISION REQUIRED	SOME SUPERVISION REQUIRED	DIRECT SUPERVISION REQUIRED
Work safely doing Electrical Task			
Understand basic Electrical Concepts			
Use Digital and Analogy Meters			
Find Shorts, opens, grounds, etc			
Repair and solder electrical wiring			
Read Section 8A Wiring Diagrams			
Circuits Covered			
Power Distribution			
Fuse Block Details			
Horn Circuit			
Heater w/AC			
Instrument Panel Gages & Indicator Lights			
Wiper Washers			
Headlamps			
Turn/Hazard/Front Marker/Front Park			
Tail/Stop/Rear Marker/License			
Interior Lights			
Power Windows			
Power Locks			
R & R Instrument Cluster			
R & R Light Bulbs			
R & R Head Light Switch			
Find Electrical Components & Test Circuits			

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Once we arrived at the skills and goals (based on the previous tasks) that we wanted to see our students demonstrate, we then began to build the program and the curriculum around them. Much of this, of course, has an effect on teaching methodology as well as on curriculum structure and how it is presented.

3. How did you apply the National Skill Standards for your assessment?
During the course, we have an assessment process that is ongoing where we require students to actually complete tasks in the learning activities in the different modules. Students learn to develop those skills that are necessary to meet the skill standards. The assessment does not just include a final evaluation. However, a final evaluation comprised of worksheets, direct observations and a General Motors test may be one or two days in length in order for students to demonstrate their skills.

4. What strengths do you see coming from this project?
I believe that the overall strength of this project is getting away from the traditional education model and moving towards a more student-centered, competency-based model. This will allow us to be much more competitive in providing and producing students with education that develops them into the most skillful workers possible.

5. What surprised you?
I believe the greatest surprise to me was the resistance of other instructors to the development of this model. Also, what surprised me was that students who we felt would only learn well in the traditional lab/lecture situation began to like and to work well with this system of learning.

6. What problems did you encounter?
Here again, the resistance of some instructors to begin to incorporate the model into their curriculums. Time was also a major problem. We deal with sessions, not semesters. A student has 35 contact hours when he/she is not on co-op. Something else that is interesting is that students take a subject like English over a twelve week period, not their usual 8 week session. Thus, time in a competency-based system revolves around the student not around the instructor. Another feature is that the curriculum is neither large nor complex. It can however take much more time than would normally transpire in a lecture/lab situation.

7. How did you cope with the problems?
We have had to go outside, way outside, the normal classroom hours in order for students to complete their task. The Automotive program has a high number of contact hours. Students will still be working late in the afternoons; 5, 6, 7 o'clock, in order to complete the requirements for the program.

8. What changes have you made?
We have made major changers in the way we have developed our curriculum to present our educational material. We have moved from being instructor-centered to being student-centered. We have also changed the old-fashioned concept of students will spend the time necessary for the development of their skills in the area and in the ways that will serve them best.

9. What changes are you planning to make?
We plan to integrate this model into all of our courses. Currently, we are about 75% complete and we will be moving to 100% completion by the next year. Our goal is to turn out a better product. We also hope to extend the concept of contextual competency-based learning with other schools in the New Hampshire Community Technical College System and with other high schools around the state of New Hampshire.

10. What benefits would faculty in other academic and technical disciplines discover if they use National Skill Standards in their own fields?
They would find that their students regardless of their academic background and other skills would begin to develop a deeper appreciation for the subject matter which they are teaching. They will

begin to notice that students really learn and are able to apply what they had learned in the classroom.

11. What differences did it make in your teaching?
As was mentioned earlier, teaching methodologies are going to revolve around the necessity for students to become more involved in their educational process. The students will take on a different teacher/student relationship, the one currently used in the lecture/lab concepts.

12. Is this methodology the most effective vehicle to deliver information to your students? Why or why not?
I believe at this point it is one of the most effective ways to deliver material to students. It is dependent, however on a lot of instructional materials, both instructor developed and developed outside of the classroom. Because of the way our students learn and because of their background in technology multimedia, individually used multimedia is a critical part of this process as well.

13. List the documentation you possess that supports your responses.
Each year, we survey the employers of our students who have completed our program and we are finding that our employers are much happier with the quality of student that we are turning out to them. This is done through surveys which are available for examination.

The Virtual Workplace
Questionnaire
Jackie Griswold

1. How did you get involved in this project?
I was asked by Keith Bird to consider being involved with the project. I saw it as an opportunity to work with people involved in a project that was national in scale. I also saw it as an opportunity to not only make a contribution to the FIPSE project but also to validate my curriculum at Berlin, enable me to know where changes might need to be made, and to develop a means of measuring student mastery of curriculum by using methods to measure student performance of skills.

2. How did you apply the National Skill Standards to your instruction?
Since the Berlin Human Services curriculum was already developed, the task was one of integrating the skills standards into the curriculum. This is, I think, more unwieldy and difficult than starting with the standards and developing a curriculum on their basis.

The use of the skill standards made the choice of instructional methods revolve around what seemed the best way to demonstrate skills and the best way for students to demonstrate to the instructor the skills learned. From the beginning I enlisted the help of the students and relied on them to help devise instructional methods best suited to skills. It should be noted that no less important are the attributes. In fact, an argument can be made that attributes (values and virtues) are more directly important in human services and present greater challenges.

3. How did you apply the National Skill Standards for your assessment?
Students have to demonstrate a required level of competency for each child. We use a combination of instructor observation of student performance and student self observation and self reporting. Our department does not yet use the skills standards for determining grades. We are still integrating skills standards into the curriculum and use of the skills standards is still what I would call experimental. We are a couple of years away from using skill standards to determine course grades.

4. What strengths do you see coming from this project?
a) Emphasis on practical applications of knowledge is increasing. More real life experiences are becoming the basis for designing instructional activities.
b) Students have a clearer idea of what they should know and what they do know.
c) The graduates of the program can be marketed to the industry better and students can market themselves better.
d) The industry in the area (human services agencies) are using the skill standards to develop job descriptions and performance evaluations.
e) Generally, students are assuming more responsibility for their learning. They know what they need to learn very specifically and are able to figure out what to do to learn these skills.

5. What surprised you?
What surprised me most was the similarities between the four FIPSE projects. I initially believed that Human Services project would be remarkably different from the others. It is different in content, but the process is similar (the process of instruction and assessment) and equally remarkable, the attributes are similar. This came as a big surprise.

On the other hand, Human Services seems, as a curriculum, to have more interconnectedness between courses and require more personal growth. This became clear as I worked with the skills standards. Human services each requires greatest reliance on personal, characterological attributes and virtues. In the human services curriculum there is a lot of assessment of character.

6. What problems did you encounter
Two main problems:

a) More time was and is needed to work on this project than the College was and is prepared to allow. b) Going from time based to competency based assessment/evaluation means we need to change certain policies around grades and time limits. This is more of an anticipated problem.

7. How did you cope with the problems?
Since I think this project so worthwhile, I simply spent as much of my own time as was needed on it. It has been very difficult many times doing this.

Organizational policies/procedures that may be obstacles to implementation of skills standard will need organizational responses.

8. What changes have you made?
Course modifications were made as a result of the use of skills standards. Some skills were over represented in courses, other under represented. Interestingly, all the skills were present in the existing curriculum, but there needed to be a more balanced distribution over the courses.

Using the skills standards has resulted in practicum courses being seen as capstone courses that should be taken only after students have acquired most all the skills. While previously students would take the practicum courses earlier, using the skills standards makes clear that these courses should be opportunities for student to exhibit mastery of most, if not all, skills taught in the program.

9. What changes are you planning to make?
a) To make the skills standards the basis for student evaluation and course grades.
b) Increase variety of ways students can acquire the skills and document that they have acquired them.

10. What benefits would faculty in other academic and technical disciplines discover if they use National Skill Standards for their own fields?
a) Validation of curricula
b) Students get a greater sense of real-life work
c) Closer industry involvement with program and curriculum development
d) Used in arts and sciences it will make general education courses' relevancy clearer to students.

11. What differences did it make in your teaching?
Using skill standards resulted in less lecturing, less conventional testing, more instructor time spent "coaching". There is an increased use of portfolios. Prep work for classes has increased as emphasis on ways of assessing and documenting acquisition of skills has increased. More responsibility has been given the student for devising ways of practicing and assessing skills. It has also increased the use of out-of-class time for coaching and assessment.

12. Is this methodology the most effective vehicle to deliver information to your students? Why or why not?
"I think so - yes." It seems to be the best way a) to get students involved in the learning process, b) to master job-related skills, c) to enable students to see things more globally/organically -- students are better able to see relevancy of learnings acquired in one course to those in other courses d) several different processes can be used to learn and to document skills -- makes instruction more capable of being "customized" for needs and characteristics of students.

13. List the documentation you possess that supports your responses.
See the last year end FIPSE report (Ann Weddleton has all the "stuff").

14. Additional comments:
None

The Virtual Workplace
Questionnaire
Dave Miller

1. How did you get involved in this project?
The original four sites in the New Hampshire Community Technical College System for involvement with this project included a manufacturing discipline group from the Nashua campus. The Nashua group was unable to participate at the time when the project was funded and the start-up activities were undertaken. Contact between the Commissioner and NHTI President Dave Larrabee established that Dave Miller from the Electronic Engineering Technology department at NHTI had an interest in educational reform in the engineering technology curriculum areas as evidenced by his preparation of an NSF proposal (Electronic Design Automation and Fabrication Laboratory (EDAFL). An invitation was extended and accepted to allow me to participate in the FIPSE project.

2. How did you apply the National Skill Standards to your instruction?
The skill standards were analyzed to identify the potential impact on the existing curriculum. The two sets of skill standards that were identified as being pertinent to the EET curriculum were the Electronic Industry Foundation's (EIF) "Raising the Standard--Electronics Technician Skills for Today and Tomorrow" and the American Electronics Association's (AEA) "Setting the Standard: A Handbook on Skill Standards for the High-Tech Industry."

It was recognized that each of the sets of skill standards can be divided into three dominant groupings--skills, knowledge, and attributes. The skills area involves the abilities necessary to perform specific professional tasks such as using equipment or industry procedures. The knowledge grouping concerns the theoretical grounding of the field. Attributes identify the personal characteristics such as work ethic and interpersonal skills that are necessary for success in the workplace. It is natural that the overlap between the identified sets of skills standards is strongest in the area of attributes, an observation that is recognized as a keystone of the NHTI FIPSE project effort.

The educational community has an established record in handling the skills and knowledge categories. The more complex and interrelated attribute area has not been very successfully incorporated into traditional educational pedagogy. This was highlighted by the observation that many "help wanted" advertisements require a particular degree (traditional schooling) along with a period of professional experience (industry schooling). The question that begged for an answer was "What do they get during job experience that they do not get in school?"

A review of the differences between the workplace and educational environments revealed a startling pattern:

* workplace knowledge was more dynamic in nature--a basic assumption is that necessary knowledge is acquired on an as-needed basis in industry as opposed to the traditional canonical knowledge set established for education.

* attributes associated with teamwork and collaboration are essential for success in the workplace as contrasted with the traditionally isolated nature of the student in school.

* school work is traditionally decomposed into discrete modules where workplace activities involve the integration of a variety of skills, knowledge, and attributes.

* the traditional school environment does not lend itself to providing industry strength experiences.

It became evident that traditional modes of instruction were unable to address the essential needs identified by skills standards. An effort to incorporate more industry-like methods resulted in the

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idea of the "Virtual Workplace" (VW). In the VW, the industry methods and assessment techniques replace traditional educational methods. Isolated work, quizzes, exams, homework, lab reports, oral presentations and teacher driven assessments are replaced by team and collaborative work, progress reports, proposals, memos, design reviews, and assessment by peers, self, and management against the industry performance based skills standards.

3. How do you apply the National Skill Standards for your assessment?
The initial approach was to utilize the EIF standards for self and management review. A review form was generated that grouped the standards into functionally related sets that were used to evaluate student performance of each student. It was a trivial task to generate the traditional "A to F" type grades from these records. However, this experience has illustrated the relative uselessness of this grading system.

4. What strengths do you see coming from this project?
The future can be a scary thing to face. Business and industry have been scrambling to keep up with the exponential change in the global marketplace. The education industry has generally remained mired in the "agrarian model" of education where skills and knowledge are catalogued, maintained, and conveyed as dogma to the students.

The success associated with the initial implementation of new education paradigms drawn from industry techniques has made the future of the education industry both more comfortable and more exciting. After working in a VW teaching environment, it will be difficult, if not impossible, to return to a traditional classroom environment. This is a good thing.

5. What surprised you?
The greatest surprise was the quick adaptation and acceptance on the part of the students. In more than one case, students who were not thought of as being particularly gifted performed in the VW environment in an exceptionally professional manner. The "grade game" was replaced by the pride in performing real work, and the greatest reward was from an internal source rather than the a"grade the teacher gave me."

6. What problems did you encounter?
Skepticism by administration and peers was the greatest external source of problems. Problems caused by inexperience with this experimental pedagogy are easily addressed by examining the issues identified by the initial experiences in the VW environment.

7. How did you cope with the problems?
Thick skin combined with the belief that "If you build it, they will come."

8. What changes have you made? (I assume you mean in terms of my philosophy of education -- the details of the pedagogical changes are covered in previous questions.)
The cumulative effect of the changes has resulted in a radically new perception of the role of the education industry in the rapidly changing world. This role is based on the recognition that education is an industry. As such, it has products, customer, and suppliers. Only by acknowledging this fact can the education industry work to produce the quality and quantity of products that the customers demand as well as work with the suppliers to recruit students into a system that can ensure their professional success.

9. What changes are you planning to make?
The challenges ahead are primarily in creating the changes in the management and traditional expectations of the education industry to incorporate performance based learning informed by National Skill Standards. This cannot be done in a "band-aid" manner -- picking and choosing the isolated points that create a cosmetic illusion of pedagogical change. Rather, it requires a systematic approach that harbors no "sacred cows" to develop a successful implementation of an education company that can prove the new paradigm of the next generation of education industry.

10. What benefits would faculty in other academic and technical disciplines discover if they use National Skill Standards for their own fields?
The faculty who would successfully base their teaching on NSS would find that they would become more involved with the industries that utilize their disciplines. Additionally, they would think less in terms of the "silo" (vertical, isolated, no windows, fermentation buildings for single subjects) department model and more in terms of an integrated model of subject areas.

The successful faculty would work harder, play more, and have more fun than they every thought possible. The VW/PBL/NSS approach requires more from, and returns more to all of the participants.

11. What differences did it make in your teaching?
Teaching under a VW/PBL/NSS system involves significantly more learning and substantially less preaching than traditional methods. Since the problems are real, they do not have singular "right answers." Thus, the method of approaching a problem is far removed from the "plug and chug" or "regurgitate" uni-polar exercises that teachers have used for centuries. Conceiving, evaluating, developing, and assessing solutions to problems creates continuously changing activities and sets of knowledge and skills for success. The common thread to each experience is that the attributes and processes are emphasized, with the demand on all participants to contribute with the best of their abilities for the success of all. For the teacher, the roles of the "sage on the stage," "guide on the side," and "mentor in the center" are augmented by the "learner on the burner." For the students, the "learner on the burner" role is augmented by the "sage on the stage," "guide on the side," and "mentor in the center."

12. Is this methodology the most effective vehicle to deliver information to your students? Why or why not?
a) No.
b) Delivering information is a residue from the agrarian model of education. Information is no longer a linearly quantifiable product that must be impressed on the students to qualify them for entry to the real world. The very nature of knowledge has changed. In years gone by, everything that a person would need to know could be learned from them. The basic knowledge required for living changed little from generation to generation. Today, the knowledge necessary for success in a profession changes so rapidly that, in many fields, it can be measured in half-lives of three to five years. Consider the computer field; in just three years, the World Wide Web has emerged from the laboratory to dominate the activities of computer professionals. It is projected that in a few short years, the current HTML based Web technology will be replaced by the spin-offs from today's Java/JavaScript/SGML/VRML/CGI leading edge Web techniques. In such a rapidly changing field, is it possible to identify a linear list of information that must be mastered in time to avoid obsolescence? (Answer: Obviously not!)

Instead, the process of acquiring knowledge and skills as necessary to solve rapidly changing problems is the key for success. The process becomes the cornerstone of learning success. The VW utilizes real problems to exercise the process to develop the skills identified in the skill standards. This approach not only accommodates, but actually requires that those "difficult to identify" attributes such as responsibility, self-learner, team worker, and communicator be incorporated and assessed in the learning environment. Thus, the new paradigm is a revolutionary rather than an evolutionary change.

13. List the documentation that you possess that supports your responses.
For example??? (What do I look like, the White House? ;-) Perhaps Ann has the records that you would need as part of the FIPSE progress reports.

14. Additional comments:
Radical, eh?

The Virtual Workplace
Questionnaire
Sonia Wallman

1. How did you get involved in this project?
It was through my involvement with the Bioscience Industry Skill Standards (I became a technical advisor to the Education Development Center (EDC) Bioscience Industry Skills Standards project early in 1993.). Also, in July 1994 I received an Advanced Technology Education (ATE) grant from the National Science Foundation (NSF) to build a lab and create the curriculum for Biotechnology technician education and training. It was a natural leap to create the curriculum to educate and train biotechnology technicians with the Bioscience Skill Standards in mind (These skill standards were created for technical workers in pharmaceutical companies, biotechnology companies, and clinical laboratories). Later I also became technical advisor to the Agricultural Skills Standards project. Finally, I am a member of the Content Selection Task Force for the SciTeK Project of High Schools and in this project I am also looking at the Skill Standards for the Chemical Process and Environmental industries.

2. How did you apply the National Skill Standards to your instruction?
Informed by my involvement with the Bioscience Industry Skill Standards project, I created a real biotechnology workplace containing real world biotechnology tools (the Virtual Workplace). Then I created a logical series of biotechnology research protocols and manufacturing standard operating procedures that use these tools and serve to unveil the entire biotechnology content area to the student. The steps in each protocol or SOP were listed and the appropriate Bioscience Industry Skill Standard were identified for these protocols and SOP's. The student receives a copy of the spread sheet created for this purpose so the student can see the relevance of their education and training to the workplace.

Industry comes in to deliver some of the knowledge base of "Biotech Experience I: Research" and most of the knowledge base of "Biotech Experience II: Manufacturing". Industry representatives also are asked to give an overview of their company and their own background. For instance, one of the industry representatives (from Biogen) started as a young graduate of a 2 year program about 10 years ago, and she is now Manager of Manufacturing.

Students are made aware of the attributes necessary to succeed in the field, and they develop these attributes during the course.

3. How did you apply the National Skill Standards for your assessment?
As the student proceeds through a biotechnology protocol or SOP, there are places where documentation of the skills is required. I look at each student's documentation to determine if the student acquired the skills. The skill documentation is graded on a 5 point scale with 0 = not aware, 1 = aware, 2 = competent, 3 = master, and 4 = expert.

Assessment of knowledge comes about through a final exam.

Assessment of attributes comes about through memos from fellow students or from observation and documentation by the instructor(s).

4. What strengths do you see coming from this project?
The skill standards create a believable structure for competency based learning; in my case a hands-on approach that encourages students to become proficient in the skills of biotechnology. Learning the skills creates a natural platform off of which to dive into the knowledge base behind the skill; students pick up the attributes as they go along.

5. What surprised you?
What surprised me is that the skills assessment piece was so easily accomplished. At first assessment of skills seemed mind boggling for there were so many skills. However, I soon learned that if it takes a series of skills to perform a protocol or SOP and the documentation looks good that means the student has correctly performed the skills. The easiest illustration of this is a protocol or SOP involving gel

electrophoresis. This protocol takes the better part of a 5 hour class period and involves a myriad of skills. The end result of this protocol is a photograph of the gel. If the photograph looks good (I like to say, "publishable") then the student must have carried out the steps in the protocol.

Another big surprise is that the industry skill standards appear to be cross functional, i.e. as a student trains to become a biotechnology technician, these skills are often identical to those skills needed to become a chemical process technician, a hazardous materials technician, etc.

6. What problems did you encounter?
The two biotechnology cornerstone (some call them capstone) courses that I developed with the Bioscience skill Standards in mind, "Biotechnology Experience I: Research" and "Biotechnology Experience II: Manufacturing", are skills oriented and student driven. I find some students have no idea how to behave in such an environment. These are the "old time" students who are looking to be fed and led. In our "virtual workplace" students are expected to know what to do whether it be wash the glassware, make a buffer or media, or assemble the tools needed for the current protocol or SOP. Some students are not comfortable with this format.

7. How did you cope with the problems?
Give them time to adapt to this new way of learning. In one case it took the student till the end of the second cornerstone course to "get it".

8. What changes have you made?
I have not made any substantive changes since the beginning of the course except to add a protocol or SOP here and there to make the flow of skills and information more and more logical and representative of industry. One example of this is the addition of a series of protocols (Protocols X-XVI of the Biotechnology Research Protocols) that involve the extraction of mRNA from CHO cells containing recombinant human tPA, the reverse transcription of mRNA into cDNA, the ligiation of cDNA molecules into vectors, the transformation of bacterial cells with these vectors, the screening of resultant colonies for tPA cDNA, and the amplification, isolation and sequencing of tPA cDNA. This series of protocols was worked out with the help of John Wold, a former student that became a summer technician in 1995. This series of protocols has been used to demonstrate current biotechnology research strategies to a class of UNH seniors in Chemical Engineering.

With the help of another former student and a UNH Chemical Engineering graduate who is a Biochemistry graduate student, some of the Biotechnology Manufacturing SOP's were refined and developed. These include SOP IX (Process Controlled Fed-Batch Fermentation of Recombinant HSA Secreting *Pichia pastoris* by Rachel Kroe and Sonia Wallman) and SOP V and VIII (Ion Exchange Chromatography of tPA and Final Affinity Chromatography/Isolation of tPA by Ellen Eckerson and Sonia Wallman).

9. What changes are you planning to make?
I need to refine and develop two additional Manufacturing SOP's. They are SOP VII and SOP X (Tangential Flow and Diafiltration of HSA and Isolation and Purification of HSA). I am planning to finish these up this summer with the help of Ellen Eckerson.

I have another grant, a Sloan Foundation grant to convert "Biotechnology Experience II: Manufacturing" into a format that can be delivered to technicians-in-industry over the Internet via the Biotechnology Center's HomePage. I am very much looking forward to allowing the technicians-in-training at the virtual biotechnology workplace at Pease access to these materials. For people who are insecure about what it is they have to do, they can practice the SOP of the day using the computerized version of the module that will be available on the Internet. These additions will be implemented for Biotechnology Manufacturing during the Fall semester.

I am hoping I can get additional funding from the Sloan Foundation to repeat this process for "Biotechnology Experience I: Research".

10. What benefits would faculty in other academic and technical disciplines discover if they use National Skill Standards for their own fields?

It depends on how they use them. This methodology that we have developed to create A Virtual Workplace from which the skill standards naturally flow may be unique. In general, however, no matter how the skill standards are used they give educators a more concrete understanding of the needs of industry. That allows a teacher to craft a learning experience that has more relevance to industry.

For example, in most college science classes students would learn on paper how to make a 100mM solution of potassium chloride. If the class has a lab and the lab exercise calls for 100mM potassium chloride, the teaching assistant or professor would make up the solution before class. If these students became employed in Biotechnology research one of the first things that they would be required to do is to make such a solution. My experience is that the average student trained in this way cannot properly create such a solution. In the virtual workplace all solutions are prepared by the students. Which student would you rather hire, the student that can make a solution on paper or the student who can actually prepare the solution?

11. What differences did it make in your teaching?

I do all the planing for the course, provide all of the tools (equipment, supplies, wet ware) and industry recognized protocols and SOP's. Then I let the students take over. They work as individuals in teams. They organize and carry out the work of the day. I take a back seat, enabling the students to learn the skills, knowledge and attributes of their field.

Also, the teaching and independent student learning center or "synergy center" provides students with any additional information they might need including information from books, journals, vendor catalogs, video tapes, audio tapes, and the Internet.

This creates independent learners.

12. Is this methodology the most effective vehicle to deliver information to your students? Why or why not?

I think this methodology is most effective in giving my students the biotechnology knowledge base and allows them to develop biotechnology skills and attributes as well. This method of teaching enables students to interact with all aspects of the biotechnology field and gives them first hand knowledge of how to get around in the field. This creates an independent and life-long learner. The best analogy to this process that I know of is home schooling where children retain the joy of learning since they have a far greater influence on the direction that their leaning process will take. Of course this is also what happens at the workplace.

13. List the documentation you possess that supports your responses.

The Biotechnology Information Package contains most of the documents including the following: Introduction, The Physical Facility Creates a "Virtual Workplace", Layout of the "Virtual Workplace", Biotechnology "Tools of the Trade", Biotechnology Associate in Science, Diploma and Certificate Programs, The Cornerstone Courses: Biotechnology Experience I: Research and Biotechnology Experience II: Manufacturing-Syllabus and Lecture Schedules, and the table of contents from Biotechnology Research Protocols and Manufacturing Standard Operating Procedures: A Manual for Technicians-in-Training.

Also available are the skills assessment sheet and student assessment database. The latter summarizes, for each student, the acquisition of skills, knowledge and attributes.

Finally, also available around August will be the "final" version of the above mentioned manual.

14. Additional comments:

Please visit.

Appendix D: Student
Assessment: Skills Point System Example

Biotechnology Student Data

MODULE 3: DOWNSTREAM PROCESSING
IPA CONCENTRATION, ISOLATION AND PURIFICIATION)

Protocol Analysis & with SOP Documentation for:	
Ion Exchange Chromatography of tPA	4
SDS-PAGE Electrophoresis of tPA	4
tPA (or HSA) Tangental Flow Diafiltration	4
tPA Affinity Chromatography	4
Chromatograms	4
Gel documentation	4
MODULE 3: TOTAL POINTS	*24*

Total Points Possible for Module 3: 24
Maximum Points (Modules 1,2,3): 80

MODULE 4: PROCESS CONTROL WITH recombinant Pichia pastoris
PROCESS CONTROL W/ recombinant Pichia pastoris

Protocol Analysis & with SOP Documentation for:	
Yeast Culture and Harvest of Media	4
HSA Chromatography	4
HSA Elecrophoresis	4
Photodocumentation of Yeast	4
Graphs of Pichia Growth Parameters	4
MODULE 4: TOTAL POINTS	*20*

Total Points Possible for Module 4: 20
Maximum Points (Modules 1,2,3,4): 100

MODULE POINTS (SKILLS) TOTAL 100

FINAL GRADE IS BASED UPON THE FOLLOWING CRITERIA: **FINAL POINTS**

SKILLS:	100 points	(75 % of grade)	75 points	MAX=75 points
KNOWLEDGE:	100 points	(15 % of grade)	15 points	MAX=15 points
ATTRIBUTES:		(see list below)	5 points	0- 5 points

ATTRIBUTES

Accountability	Honesty	Safety Consciousness
Alertness	Independent Worker	Scientific Curiosity
Common Sense	Integrity	Self-Motivation
Compassion	Interest in Work	Sound Judgment
Confidentiality	Leadership	Tactfulness
Conscientiousness	Meticulousness	Takes Initiative
Courteousness	Observant	Thoroughness
Creativity	Patience	*Willingness:* to Ask For Help
Flexibility	Positive Attitude	to Work Around Hazardous Chemicals
Handles Constructive Criticism	Professional Attutude/Behavior	to Work Around Microbiologic Pathogens
Handles Failure	Reliability	to Work Around Radioactive Materials
Hard Working	Responsibility	Works Well With Many Different People

RESUME WITH COVER LETTER:	5	0- 5 points
EXTRA CREDIT:	5	0- 5 points
GRAND TOTAL OF POINTS	105	MAX=105 points

SKILLS POINT SYSTEM:
AWARENESS: 1 COMPETENCY: 2 MASTERY: 3 EXPERTISE: 4

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